Draft Report

केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

Devanahalli Taluk, Bangalore District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region,Bengaluru

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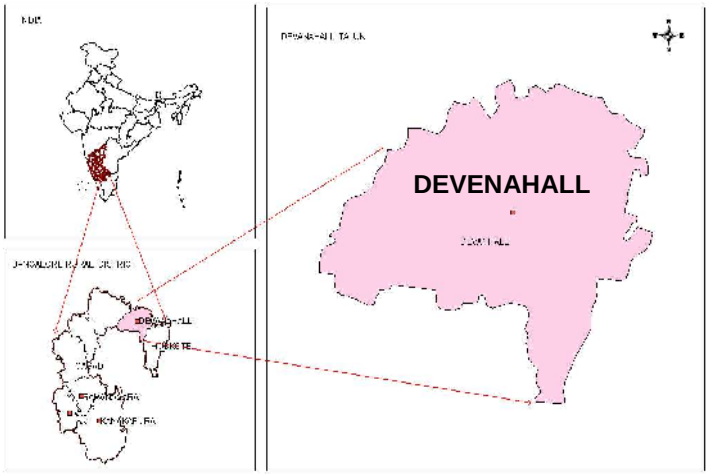
Central Ground Water Board

DEVANAHALLI TALUK AQUIFER MAPS AND MANAGEMENT PLANS, BANGALORE RURAL DISTRICT, KARNATAKA STATE



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March 2017

DEVANAHALLI TALUK AQUIFER MAPS AND MANAGEMENT PLANS, BANGALORE RURAL DISTRICT, KARNATAKA STATE

CONTENTS

DEVANAHALLI TALUK AQUIFER MAPS AND MANAGEMENT PLANS, BANGALORE RURAL DISTRICT, KARNATAKA STATE

1. SALIENT INFORMATION

Name of the taluk : **DEVANAHALLI**
District : Bangalore Rural
State : Karnataka
Area : 450 sq.km.
Population : 2,09,622 (2011)
Annual Normal Rainfall : 804 mm

1.1 Aquifer management study area

Aquifer mapping studies was carried out in Devanahalli taluk, Bangalore Rural district of Karnataka, covering an area of 450 sq.kms under National Aquifer Mapping Project. Devanahalli taluk of Bangalore Rural district is located between north latitude $13^0$06'44.0" and $13^0$21'53.7" & east longitude $77^0$33'26.7" and $77^0$50'04.4", and is covered in parts of Survey of India Toposheet Nos. 57G/11, 57G/12, 57G/15 and 57G/16. Devanahalli taluk is bounded by Chikballapur taluk of Chikballapur district on north, Bangalore North taluk of Bangalore Urban district on south, Hoskote taluk & Sidlaghatta taluk of Chikballapur district on east and Doddaballapur taluk on western side. Location map of Devanahalli taluk of Bangalore Rural district is presented in Figure-1**.**

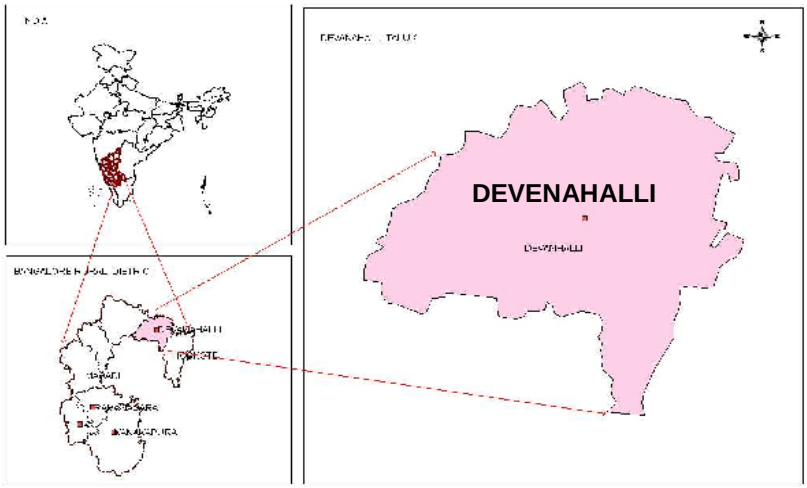

Fig 1: Location Map of Devanahalli Taluk,

Taluk administration of Devanahalli taluk is divided into 4 Hoblies and Devanahalli is only one town, which is also the taluk head quarter. There are 193 inhabited and 21 uninhabited villages in Devanahalli taluk (Table-1).

Table 1: Administrative divisions of Devanahalli taluk, Bangalore Rural district

Taluk	No. of Villages		VA circles	Hoblies	Gram Panchayats	Municipalities	Cities / Towns / Urban Agglomeration
	Inhabited	Uninhabited					
Devanahalli	450	193	21	34	4	21	2

Source: District at a glance 2014-15, Govt. of Karnataka

1.2 Population

According to 2011 census, the population in Devanahalli taluk is 2,09,622, comprising 1,07,842 males and 1,01,780 females. Out of the total population of 2,98,070, nearly 1,46,705 constitute the rural population and 62,917 is the urban population, which works out to 70% (rural) and 30% (urban) of the total population of taluk. The study area has an overall population density of 465 persons per sq.km. The decadal variation in population from 2001-2011 is 13.11 % in Devanahalli taluk.

1.3 Rainfall

Devanahalli taluk enjoys semiarid to arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Eastern dry agro-climatic zone of Karnataka state and is categorized as drought prone. The normal annual rainfall in Devanahalli taluk for the period 1981 to 2010 is 804 mm. Seasonal rainfall pattern indicates that, major amount of (447 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 56% of the annual normal rainfall, followed by North-East Monsoon season (216 mm) constituting 27% and remaining (140 mm) 17% in Pre-Monsoon season (Table-2).

On Computations were carried out for the 30 year blocks of 1981- 2010, the mean monthly rainfall at Devanahalli taluk is ranging between 1 mm during January to 165 mm during September. The coefficient of variation percent for pre-monsoon, monsoon and post-monsoon season is 54, 30 & 61 percent respectively. Annual CV at this station works out to be 31 percent (Table-2). The frequency of occurrence of drought is once in 4 years at Devanahalli taluk.

Table 2: Statistical Analysis of Rainfall Data of Devanahalli taluk, (1981 to 2010)

STATION		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
DEVANAHALLI	NRM	1	4	15	38	82	76	90	116	165	156	48	12	804
	ST.DEV	5	11	27	49	56	56	66	67	96	113	45	15	249
	CV%	548	264	182	131	68	74	74	58	58	73	94	117	31

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Devanahalli taluk. The amount of rainfall and its distribution throughout the season contributes to the cropping pattern in the area.There are two

agricultural seasons namely Kharif (June-October) and Rabi season (Mid October-Mid February). Major Kharif crops are maize, ragi, tur dal and vegetables (Table-3). Main crops of Rabi season are ragi, maize, horse gram, groundnut and sunflower. Mango plantations are the major perennial crop grown in the area.

Table 3: Cropping pattern in Devanahalli taluk 2014-2015 (Ha)

Year	Paddy	Maize	Ragi	Total Cereals and minor millets	Oil seeds	Pulses	Fruits	Vegetables	Cotton	Sugarcane
	Area under cultivation (Ha)									
2014-2015	36	494	5436	5976	81	971	3010	2005	0	0

It is observed that net sown area accounts 44% and area sown more than once is 4% of total geographical area in Devanahalli taluk (Table-4). 25% area falls under area not available for cultivation. Groundwater from bore wells forms the only source of irrigation.

Table 4: Details of land use in Devanahalli taluk 2013-2014 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Devanahalli	44935	2275	11150	6215	19826	1638

Source: District at a glance 2013-14, Govt. of Karnataka

1.5 Geomorphology, Physiography & Drainage

Geomorphologically, the taluk area is covered with uplands on Gneisses and Granites, which are ideal for agriculture. Physiography of the entire area is in southern maidan region, characterized by undulating landscape with broad valleys, where the elevation ranges from 700 to 1338 m amsl with good degree of slope. The eastern part of the taluk is covered by prominent hill ranges which are continuation of Nandidurga hill ranges running almost N-S direction and is the provenance for the sediment and drainage of Pennar. The remaining portion is having rolling topography undulating and gently sloping lands and valleys. The prominent hill ranges in the area is Devarbetta hill range with 1014 m amsl (Fig-2).

In Devanajhalli taluk, there are no perennial rivers. There are few streams that rise in the hills and feed number of tanks. Theses tributaries are ephemeral. North Pennar drains the major part of the taluk and it flows through Manchenahalli and Gauribidanur town and then enters Andhra Pradesh state. The drainage pattern of the area can be described as semi-dendritic to dendritic type. The drainage patterns are described as sub-rectangular due to marked influence of geologic structures and more or less similar lithological characters (Fig.-3).

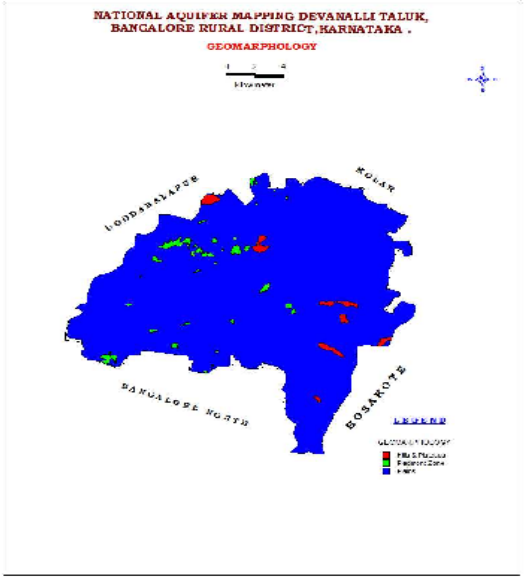

Fig 2: Geomorphology Map

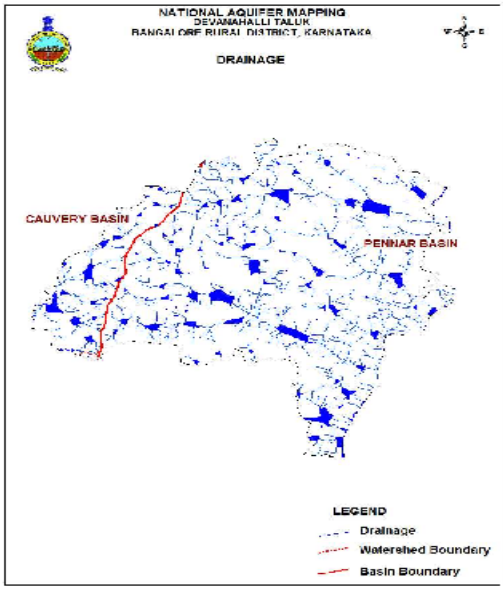

Fig 3: Drainage Map

1.6 Soil

Devanahalli taluk is covered by four classes of soils that are clayey, clayey mixed, loamy skeletal and rocky land.

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth are given in Table-5 below.

Table 5: Total GW Resources (2011) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200m)	Dynamic + phreatic in-storage + fractured
Devanahalli	4276	0	585	4862

1.8 Existing and future water demands (as per GEC-2011)

- Net ground water availability for future irrigation development : Nil
- Domestic (Industrial sector) demand for next 25 years : 3.94 MCM

1.9 Water level behavior

(a) Depth to water level

Aquifer – I : Phreatic aquifer is almost dry / desaturated due to over exploitation.

Aquifer – II : Pre-monsoon & Post-monsoon water level are given in Table below and shown in figures 4 & 5 respectively.

Pre-monsoon & Post-monsoon water level data

Taluk	Pre-monsoon Water Level (mbgl)		Post-monsoon Water level (mbgl)	
	Minimum	Maximum	Minimum	Maximum
Devanahalli	2.96	49.80	1.20	47.20

(b) Water level fluctuation

Aquifer-II (Fig.-6)

A. Seasonal Fluctuation: Rise ranges between 0.95 to 10.10 m;

Fall ranges between 0.45 to 1.50 m.

Fig 4: Pre-monsoon Depth to Water Level (Aq-II)

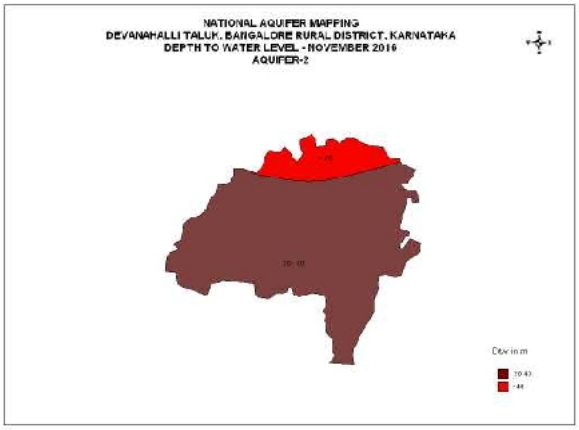

Fig 5: Post-monsoon Depth to Water Level (Aq-II)

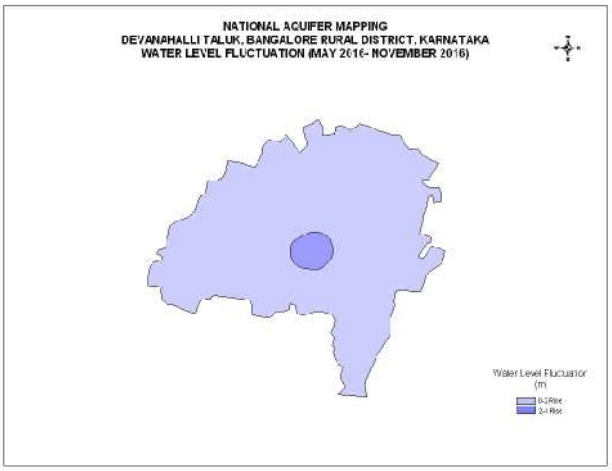

Fig 6: Water Level Fluctuation (Aq-II)

2. AQUIFER DISPOSITION

2.1 Number of aquifers: In Devanahalli taluk, there are mainly two types of aquifer systems;

i. **Aquifer-I (Phreatic aquifer)** comprising Weathered Banded Gneissic Complex / Laterite

ii. **Aquifer-II (Fractured aquifer)** comprising Fractured Banded Gneissic Complex / Laterite

In Devanahalli taluk, fractured Banded Gneissic Complex / gneisses and laterite are the main water bearing formations (Figure-7). Ground water occurs within the weathered and fractured gneisses and laterite under water table condition and semi-confined condition. In Devanahalli taluk bore wells were drilled from a minimum depth of 86 mbgl to a maximum of 381.70 mbgl (Table-6). Depth of weathered zone (Aquifer-I) ranges from 11.7 mbgl to 67.6 mbgl (Figure-8). Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 25 to 375 mbgl. Yeild ranges from 0.44 to 14.13 lps. The most productive granular zones with good discharge encountered are in between 200 to 300 m. Transmissivity ranges from 1.9 to 9.4 m^2/day. The basic characteristics of each aquifer are summarized in Table-7.

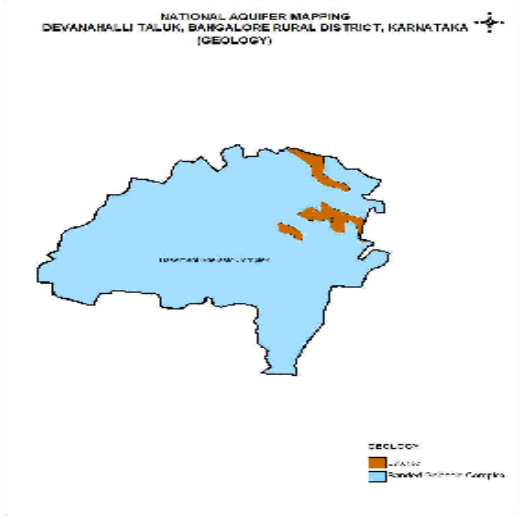

Fig 7: Geology Map

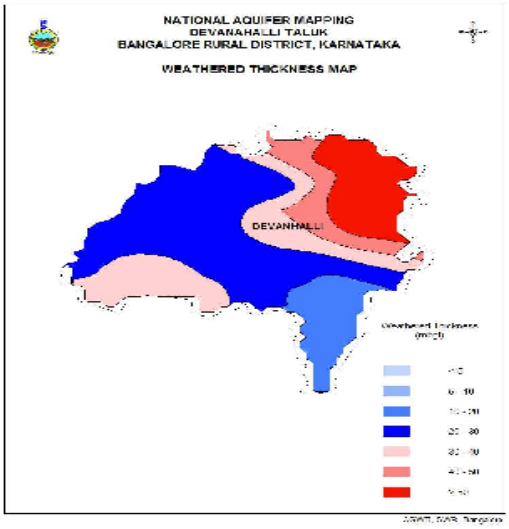

Fig 8: Weathered thickness map (Aq-I disposition)

Table 6: Details of Ground Water Exploration

Sl. No.	Location	Depth drilled (mbgl)	Casing (m)	SWL (mbgl)	Fractures encountered(m)/Discharge (lps)	Discharge (lps)
1	Gudu Mudanahally- EW, 57 G/15-3A 13° 19' 39.6",77° 46' 42.7"	357.50	54.25	171.00	235.50-236.00,271-272,1.00-301.50	0.44
2	Sigehalli- EW, 57 G/11-2B 13° 21'48.0",77° 38' 32.5"	381.70	29.40	45.60	85.80-88.90,372.50-375.60,	1.78
3	Avati -EW,57 G/11-3C 13° 18' 13.2",77° 42' 53.9"	351.30	23.30	22.35	58.50-59.50,190.00-191.00 ,210.00-211.00	0.44
4	Viswanathapura-EW, 7 G/11-3B 13° 16' 32.7",77° 38' 18.1"	342.00	24.50	138.00	153.00-154.00,257.50-258.50, 291.00-293.00	0.44

5	Bhovinahalli (Bhovipalaya) - EW, 57 G/12-1B 13° 12’ 30.9”,77° 36’ 44.7”	302.40	44.50	177.35	220.00-220.50,235.0-235.50,65.00-266.00,284.00-285.00,296.00-296.50	4.36
6	Bhovinahalli(Bhovipalaya)- OW, 57 G/12-1B 13° 12’ 30.2”,77° 36’ 45.4”	302.40	30.50	179.00	198.00-199.00,251.00-252.00,258.00-259.00	5.53
7	Baichapur- EW, 57 G/12-1B 13° 13’ 35.6”,77° 42’ 43.5”	300.00	24.00	93.30	79.00-79.50,112.00- 13.00, 191.00-192.00,270.00- 71.00	0.44
8	Doddeaballapur- EW 57 G/11-3A 13° 18’ 40.3”,77° 32’ 17.9”	250.00	11.70	79.82	24.80-25.80,45.50- 46.50, 48.20-49.20,247.00-248.00	14.13
9	VIJAYAPURA 13°17'50", 77°47'60"	263.23	67.58	12.9	60.68, 81, 264.23	0.99
10	LALGONDANAHALLI 13°17'10", 77°43'10"	242.00	40	17.8	43.25,123.60, 127.07, 242	2

Table 7: Basic characteristics of each aquifer

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered gneisses and laterite	Fractured / Jointed gneisses and laterite
Thickness range (mbgl)	30	Fracture extends upto 300 mbgl
Depth range of occurrence of fractures (mbgl)	-	30 – 300
Range of yield potential (lps)	Mostly Dry	< 1 - 5
Specific Yield	2%	0.2%
T (m^2/day)	-	1.9 – 9.4
Quality Suitability for Irrigation	Yes	Yes
Suitability for Domestic purposes	Yes	Yes
Remarks	Over exploited	Ground water in hard rocks exists within the fractures & 1 to 3 sets of fractures are likely to be encountered up to the depth of 375 m bgl.

2.2 3 D aquifer disposition and Cross-Sections

A. Aquifer disposition – Rockworks output (Fig. 9 & Fig.-10)

Based on the aquifer input data, various aquifer models viz., 3D aquifer models, 3D aquifer fence diagram and aquifer cross sections have been prepared and presented in Figures-9 & 10.

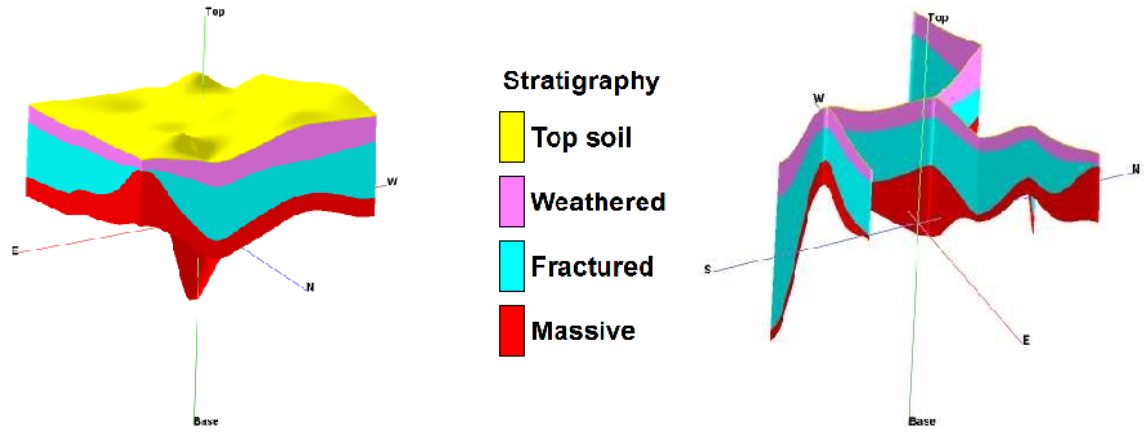

Fig 9: 3D aquifer Disposition and Fence Diagram

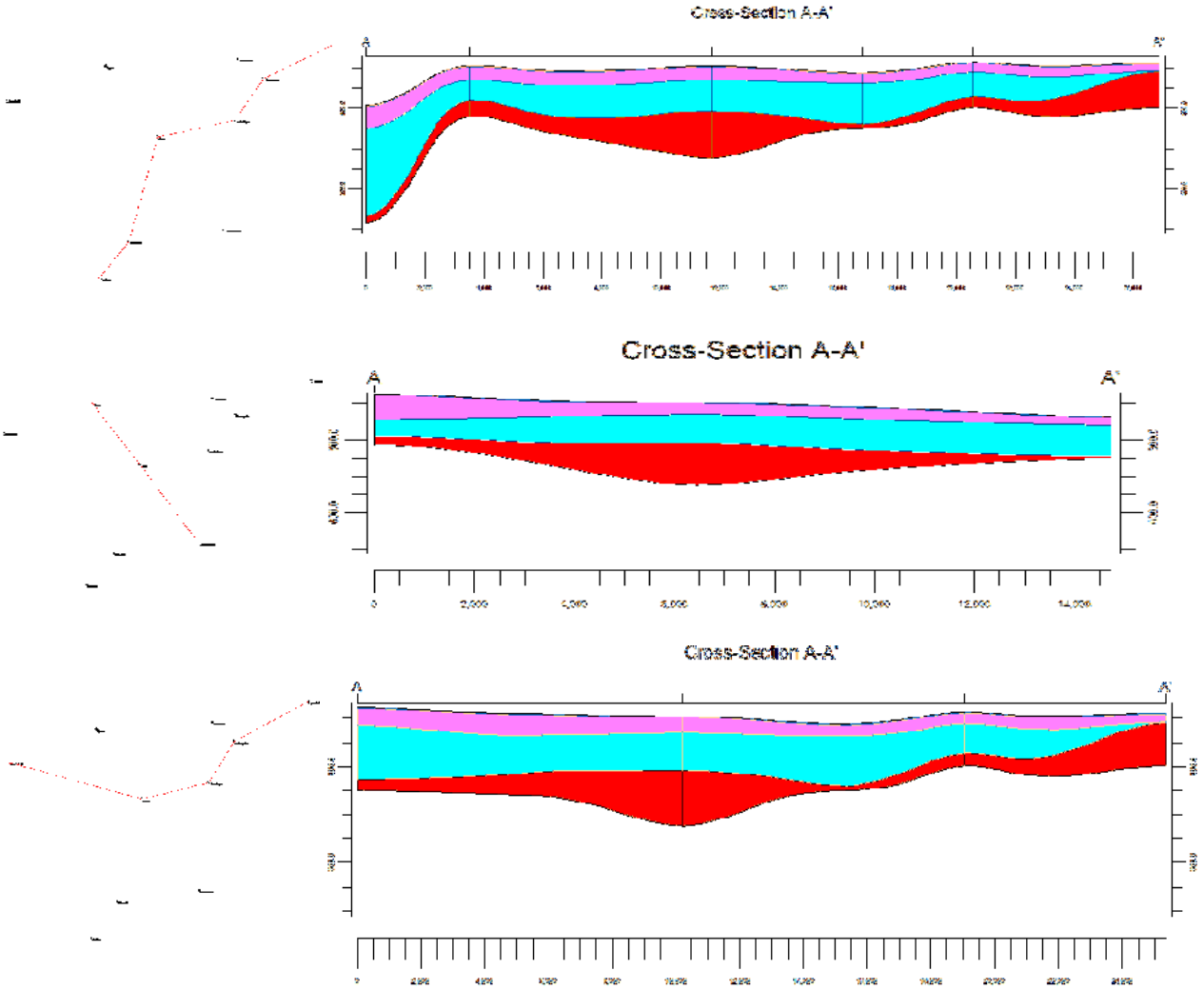

Fig 10 : Cross sections in different directions

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

a. Aquifer wise resource availability and extraction

(a) Present Dynamic Ground Water Resource (2013)

Taluk	NET ANNUAL GROUND WATER AVAILABILITY	EXISTING GROSS GROUND WATER DRAFT FOR IRRIGATION	EXISTING GROSS GROUND WATER DRAFT FOR DOMESTIC AND INDUSTRIAL WATER SUPPLY	EXISTING GROSS GROUND WATER DRAFT FOR ALL USES	ALLOCATION FOR DOMESTIC AND INDUSTRIAL USE FOR NEXT 25 YEARS	NET GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION DEVELOPMENT	EXISTING STAGE OF GROUND WATER DEVELOPMENT	Category
Devanahalli	4276	5162	394	5556	394	0	130	OVER-EXPLOITED

(b) Present total Ground Water Resource (ham)

Taluk	Annual replenishable GW resources (ham)	Fresh In-storage GW resources (ham)		Total availability of GW resource (ham)
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
Devanahalli	4276	0	585	4862

(c) Comparison of ground water availability and draft scenario in Devanahalli taluk

Taluk	GW availability (in ham)	GW draft (in ham)	Stage of GW development	GW availability (in ham)	GW draft (in ham)	Stage of GW development	GW availability (in ham)	GW draft (in ham)	Stage of GW development
	2009			**2011**			**2013**		
Devanahalli	4101	6053	148	4537	5586	123	4276	5556	130

b. Chemical quality of ground water and contamination

Range of chemical constituents from analytical results of 14 samples in Devanahalli taluk is presented in Table-8 below:

Table 8: Range of chemical constituents in ground water – Devanahalli taluk

Chemical constituents in PPM		EC in m/mhos/cm at 25 ^{0}c	Total hardness as $CaCo_3$	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	NO_3	F
Aquifer I (Dug wells)													
Range	8.01 to 8.58	430 to 2600	90 to 570	20 to 112	4.8 to 70.64	50 to 253	4.3 to 332	134 to 256	0 to 48	36 to 632	6 to 211	26 to 217	0.23 to 2.58
Aquifer II (Bore wells)													
Range	7.3 to 8.3	420 to 2470	90 to 460	32 to 80	2 to 87	47 to 202	2.2 to 290.1	116 To 622	0 to 9	36 to 426	6 to 180	5 to 120	0.6 to 1.8

Electrical Conductivity, Aquifer I: Out of 9 samples collected from dug wells representing Aq-I only, 3 samples indicate EC greater than the permissible limit of 2000 m/mhos/cm. EC values of Aq-I ranges between 430 to 2600 m/mhos/cm at 25°C.

Aquifer- II: Out of 10 samples collected from bore wells representing Aq- II, only 1 sample indicates EC greater than the permissible limit of 2000 m/mhos/cm. Fig-11 illustrates electrical conductivity of water samples representing Aq-II, which indicates ground water in larger extent has EC value within the permissible limit. EC values of Aq-II ranges between 420 to 2470 m/mhos/cm at 25°C.

Fluoride: Fluoride concentration in ground water is of geogenic origin in areas underlain by younger granites/ gneisses containing minerals like Flurospar & fluroapatite

Aquifer I: Out of 9 samples collected from dug wells representing Aq-I, 2 samples indicate EC greater than the permissible limit of 1.5 mg/l. EC values of Aq-I ranges between 0.7 to 2.58 mg/l.

Aquifer–II: Out of 10 samples collected from bore wells representing Aq–II, 1 sample indicates fluoride greater than the permissible limit of 1.5 mg/l, which constitutes 10% of the samples collected. Fig-12 illustrates fluoride concentration and its spatial occurrence in water samples representing Aq-II. Ground water in southwest and northeast of taluk has fluoride greater than the permissible limit. Fluoride ranges between 0.6 to 1.8 mg/l.

Nitrate: Aquifer I: Out of 9 samples collected from dug wells representing Aq–I, 6 samples indicate nitrate greater than the permissible limit of 45 mg/l, which constitutes 67% of the samples collected. Ground water in half of the taluk has nitrate greater than the permissible limit. Nitrate ranges between 0.3 to 217 mg/l. Nitrate contamination is due to extensive use of fertilizers, hence is anthropogenic in origin.

Nitrate: Aquifer II: Out of 10 samples collected from bore wells representing Aq–II, 5 samples indicate nitrate greater than the permissible limit of 45 mg/l, which constitutes 50% of the samples collected. Fig-13 illustrates nitrate concentration and its spatial occurrence in water samples representing Aq-II. Ground water in half of the taluk has nitrate greater than the permissible limit. Nitrate ranges between 5 to 120 mg/l.

In general, ground water quality in Devanahalli taluk is good for drinking purpose except in some areas as depicted in above illustrated maps, where nitrate & fluoride is found to be greater than the permissible limit as per “Indian Standard Drinking Water Specification 2009”. Ground water samples have also been tested and found suitable for agriculture & irrigation purposes.

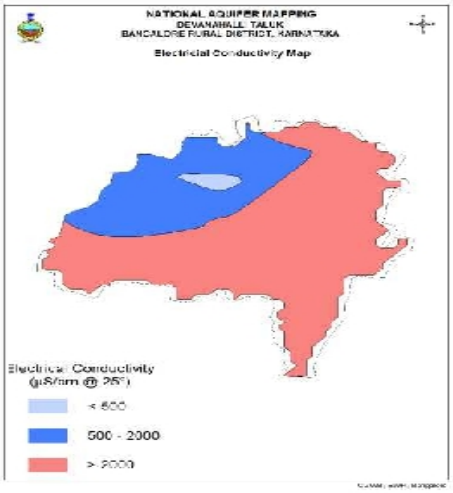

Fig 11: Electrical Conductivity Map

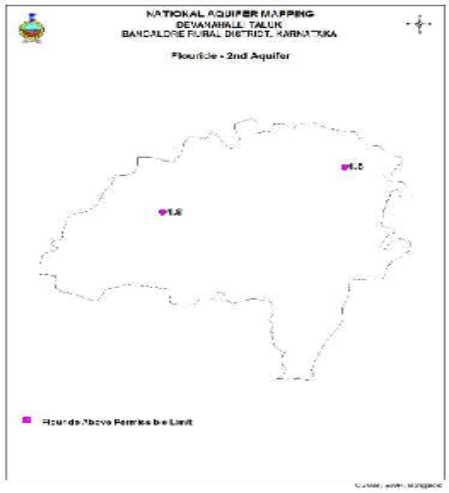

Fig 12: Fluoride Map

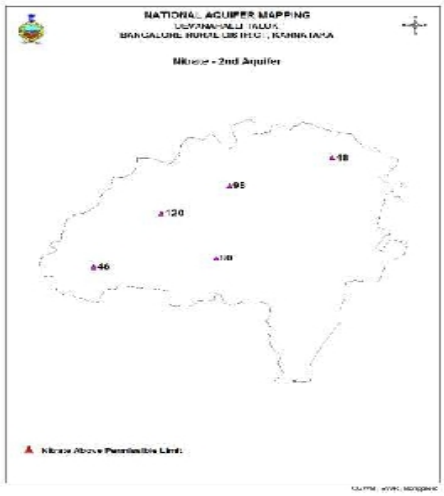

Fig 13: Nitrate Map

4. GROUND WATER RESOURCE ENHANCEMENT

a. Aquifer wise space available for recharge and proposed interventions

Recharge dry phreatic aquifer (Aq-I) in the taluk through construction of artificial recharge structures, viz; check dams, percolation tanks & point recharge structures (Table-9). The choice of recharge structures should be site specific and such structures need to be constructed in areas already identified as feasible for artificial recharge.

Table 9: Quantity of non-committed surface runoff & expected recharge through AR structures

Artificial Recharge Structures Proposed	Devanahalli taluk
Non committed monsoon runoff available (MCM)	7.8
Number of Check Dams	48
Number of Percolation Tanks	3
Number of Point Recharge structures	5
Tentative total cost of the project (Rs. in lakhs)	177.97
Excepted recharge (MCM)	4.39
Expected rise in water level (m)	0.55
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	4.25

b. Proposed Yettinahole Project

Yettinahole project is a drinking water supply scheme which neither proposes irrigation use nor development of any command areas.

The project envisages Drinking Water Supply Scheme to Bangalore Rural district along with other six districts ie. Kolar, Bangalore Rural, Ramnagaram, Tumkur, Hassan and Chickmagalur by Karnataka Neeravri Nigam Ltd, Government of Karnataka.

The project proposal comprises two components namely, drinking water and tank filling. In Devanahalli taluk, implementation of the project helps to recharge 476 Ham to groundwater by which there will be increase in the groundwater availability and the stage of GW development will come down (Table-10).

Overall, recharge through AR structures and implementation of Yettinahole project help to recharge 915 Ham of water to groundwater by which there will be 23% increase in the groundwater availability and the stage of GW development will come down to 107 % from 130%.

The increase in groundwater availability on recharging the available water from different sources and consequent change in groundwater scenario is presented in the Table-10

Table 10: Ground Water Availability and Draft Scenario in Devanahalli taluk and Expected Improvement in Stage of Ground Water Development

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Taluk	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for all uses	Existing stage of Ground Water Development	Expected Recharge from Artificial Recharge Projects	Additional Potential from proposed Yettinahole Project	Cumulative Annual Ground Water Availability	Expected Improvement in stage of Ground Water Development after the Implementation of the Project	Expected Improvement in overall stage of Ground Water Development
	Ham	**Ham**	**%**	**Ham**	**Ham**	**Ham**	**Ham**	
Devanahalli	4276	5556	130	439	476	5192	107	23

5. DEMAND SIDE INTERVENTIONS

a. Water use efficiency

Agriculture is the main occupation and source of livelihood of the rural population in Devanahalli taluk. As there are no other sources, groundwater is the only source for agriculture. Therefore, agriculture sector is major consumer of groundwater. Because of over-exploitation, dug wells are practically dry and yield of bore wells also is on declining trend. Hence, farmers are facing inadequacy of groundwater for agriculture and in the district about 70% of the farmers have adopted to change in cropping pattern and water economy irrigation practices like drip irrigation and sprinkler irrigation.

Heavy water consuming crops like paddy is grown in less than 1% of the net sown area and sugarcane is not grown. If, the remaining 30% farmers also adopt the water use efficient irrigation practices, there will be additional saving in water. Therefore, encouragement from government is essential for achieving full target of water use efficiency in the district.

Cropping pattern change and efficient irrigation techniques will contribute in saving ground water by 347 ham and thus will improve stage of development by 7% from 107% to 100% (Table-11).

Table 11: Improvement in GW availability due to saving by cropping pattern change & Adopting water use efficiency

Taluk	Cumulative annual ground water availability after implementing AR structures & Yettinahole project	Existing gross ground water draft for all uses	Stage of ground water development after implementing AR structures & Yettinahole project	Saving due to changed cropping pattern	Saving due to adopting water use efficiency (WUE) measures	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of the savings	Expected improvement in overall stage of ground water development
	HAM	**HAM**	**%**		**HAM**	**HAM**	**%**	**%**
Devanahalli	5192	5556	107	25	322	5539	100	7

b. Regulation and Control

- Devanahalli taluk has been categorized as Overexploited, since the Stage of ground water development has reached 130% (GEC-March 2013). Hence, stringent action has to be taken up through Karnataka Ground Water Authority to control further ground water exploitation in the taluk.
- Ground water recharge component needs to be made mandatory in the taluk.

c. Quality issue management options

The main quality issues in the Devanahalli taluk are fluoride and nitrate in both the aquifers. But, they are sporadic in nature. Fluoride is geogenic. Nitrate contamination is local in nature and is anthropogenic.

For remediation, the following management measures are suggested.

- Alternate source
- Removal technique
- Artificial recharge
- In-situ rainwater harvesting
- Centralized drinking water supply from Yettinahole Project
- Prevention of contamination

6. SUMMARY

The summary of Management plan of Devanahalli taluk is given in Table-12.

Table 12: Summary of Management plan of Devanahalli taluk

Devanahalli taluk is over-exploited & present stage of GW Development (2011)	130%
Net Annual Ground Water Availability (MCM)	42.76
Existing Gross Ground Water Draft for all uses	51.62
Groundwater development feasibility	NIL
Total GW Resources (Dynamic & Static upto the depth of 200 mbgl) (MCM)	48.62
Expected additional recharge from monsoon surplus runoff (MCM)	4.39
Change in Stage of GW development, %	130 to 118
Expected additional recharge from Proposed Yettinahole project (50% live capacity of MI tank) (MCM)	4.76
Change in Stage of GW development, %	118 to 107
Expected Saving due to adopting cropping pattern change & WUE measures (MCM)	3.47
Change in Stage of GW development, %	107 to 100 %
Water Use efficiency measures	• 70 % farmers have adopted water use efficiency irrigations practices like dip & sprinkler irrigation • Water intensive crops (Paddy & Sugarcane) are being cultivated in <1% of net sown area and • Government to take initiative to encourage remaining 30% farmers to adopt water use efficiency irrigations practices
Groundwater quality aspects - Fluoride & Nitrate	• Alternate source • Removal technique • Artificial recharge • In-situ rainwater harvesting • Centralized drinking water supply from Yettinahole Project • Prevention of contamination